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GEOGRAPHICAL DIFFERENCES IN CONCENTRATIONS OF ICE NUCLEI

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ABSTRACT

On the basis of mixing chamber measurements of the concentrations of ice nuclei at Mauna Lao it is suggested that Kline's conclusion that the counts were conspicuously lower than elsewhere, may have been instrumental in origin.

Kline [1] discussed the results of a program of measurement of ice nucleus concentrations at 15 observational sites in the United States using expansion counters and concluded that they showed a dominant contribution by terrestrial aerosols to the ice nucleus budget of the lower atmosphere. This conclusion hinged on very extensive measurements at the high altitude observatory (11,150 ft.) on Mauna Loa, Hawaii, which for a large part of most

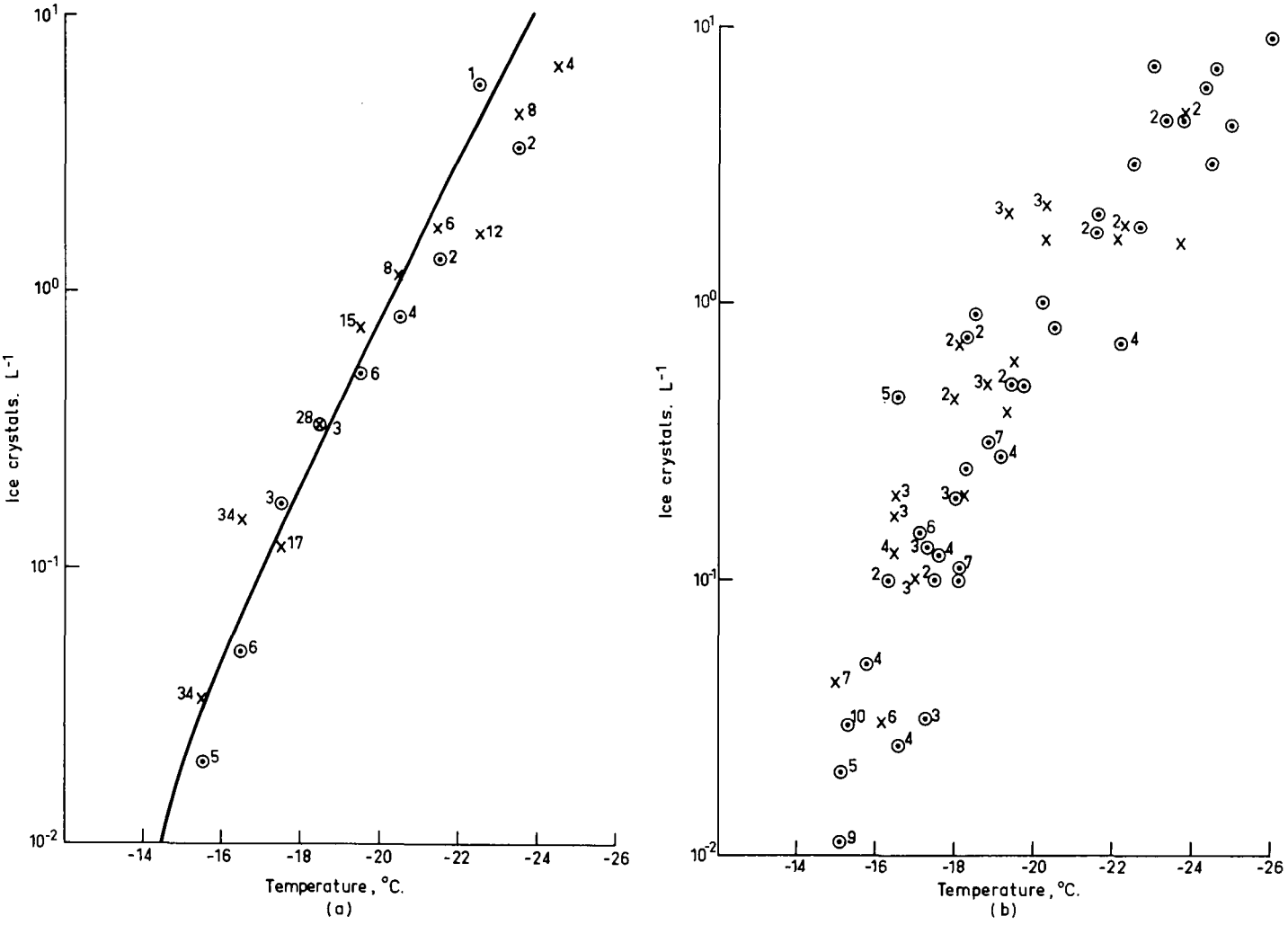

FIGURE 1.—(a) Mean of all ice crystal measurements by 1° C. intervals, at Mauna Loa (x) Hilo (⊙) and for comparison, Sydney (solid line) 1956–57. The numbers are the number of measurements corresponding to each point. (b) Measurements of ice crystal concentrations at Mauna Loa in up-slope (⊙) and down-slope wind conditions (x).

days is well above the trade wind inversion. The fact that counts were a factor of 10 lower than those made at Hilo (near sea level on the same island) and at all mainland sites appears strong evidence in favor of this conclusion.

In order to operate the counter successfully it is necessary that the humidity within it should exceed water saturation during the expansion and that the cloud which forms should be stable for at least a minute. Otherwise ice crystals will fail to grow large enough to reach the detecting solution at the bottom of the chamber in the available time and an undercount will result.

Although pure glycerine is used on the walls to prevent frost, the ambient dew point is usually sufficiently high for its surface layer to become diluted during the period when the air in the chamber is changed, and it does not therefore depress the humidity unduly. When the dew point of the outside air is less than the wall temperature of about $-10°$ C. this does not happen and there is a risk of an undercount. Since the dew point on Mauna Loa, alone of all the stations, is commonly less than this except in the afternoon, it is essential to test whether a technique in which moisture is added to the cold chamber for each experiment yields the same answer.

With the kind cooperation of Mr. Jack C. Pales (then Physicist in Charge at Mauna Loa) and Mr. Kline, such a check was made in August 1963.

In the short time available the most important experiments were (a) to take measurements at Mauna Loa Observatory and at Hilo with as little time separation as possible; (b) to compare measurements made at the Observatory in descending air (night and early morning) with those made in rising air during the afternoon. The expansion instrument was simply used as a mixing chamber, by varying the wall temperature in small steps, moisture being added after each change of air.

Measurements were made from 1700 LST on August 16 to 0800 LST on August 19, with the exception of about eight hours each night, and from 1100 to 1600 LST August 19 at Hilo. The results are shown in figure 1 (a) and (b). Clearly there is no appreciable difference among the various sets and they are also remarkably similar to mean values found at sea level in Australia, curves of which have been published by Bigg and Hopwood [2].

This does not mean that Kline's conclusions are wrong, for there is always the chance in relatively short sequences of observations that the period was not a typical one. It does suggest, however, that his conclusions cannot be regarded as proven until a careful assessment is made of why different techniques yield such different answers.

REFERENCES

1. D. B. Kline, "Evidence of Geographical Differences in Ice Nuclei Concentrations," *Monthly Weather Review*, vol. 91, Nos. 10–12, Oct.–Dec. 1963, pp. 681–686.
2. E. K. Bigg and S. C. Hopwood, "Ice Nuclei in the Antarctic," *Journal of the Atmospheric Sciences*, vol. 20, No. 3, May 1963, pp. 185–188.

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